Comparing the 3.5-cm Radar Reflectivity of Mars and Mercury

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We have used the combined VLA/Goldstone radar instrument many times in the last 6 years to obtain *unambiguous* full-disk images of 3.5-cm radar cross section for Mars and Mercury. The transmitted wave is Right Circularly Polarized (RCP), and we image at the VLA in both RCP, and Left Circular Polarization (LCP). We refer to the received RCP signals as SS (for Same Sense as transmitted) and the received LCP signals as OS (for Opposite Sense as transmitted). These experiments have provided a rich harvest of new information about the surface and near-surface of both planets, some of which will be discussed here.

Global cross sections indicate that Mars is a much more efficient backscatterer at 3.5 cm. The average global cross sections for the 91 geometries in which we have observed Mars are ~ 21.3% and ~ 7.5% for the OS and SS polarizations, respectively. For the 4 geometries in which we have observed Mercury, the average cross sections are ~ 9.9% and ~ 1.9%. The backscatter cross section can be thought of to first order as some combination of the true Fresnel reflectivity and the "roughness" of the sulfate. Since the true Fresnel reflectivities of most natural surfaces are fairly similar, Mars is probably much rougher than Mercury on size scales of centimeters. This is also indicated by the higher average polarization ratio (ratio of SS to OS cross section), which is ~ 1/3 for Mars, and ~ 1/5 for Mercury. We cannot, however, exclude the possibility that there is some compositional difference in the surfaces of the two planets, which may cause some difference in the intrinsic reflectivity. We should mention here that these results have been known to some extent since the mid 1960's.

Mars also has a surface which displays a greater diversity in the local values of its cross section. The range of cross sections extends from areas with nearly unity cross section to those with no measureable cross section. This is not the case with Mercury, where variations are much more subdue'd. There are no locations which we have imaged on the surface of Mercury which have no measureable cross section, similar to the "Stealth" region of Mars. Both planets have their maximum cross sections in polar regions, aside from locations very near the subearth point. On Mars, the south polar residual ice cap had a near unity SS cross section and a polarization ratio > 1 when probed in 1988, at ~ 65° incidence angle. When probed in 1992/93, the north residual cap had no cross section enhancement. The difference in the cross section of the two residual caps must be due to some combination of different structure/composition, different season, and different viewing geometry. On Mercury, both polar regions have cross section enhancements, however, the peak SS cross sections are only ~ 10%. The polarization ratios are still > 1, indicating that the enhancements there are also caused by large ice deposits. The difference in the cross sections of the Mars south residual cap and the polar regions of Mercury lies mainly in the different aerial coverage of the ice deposits. On Mercury, the ice only remains stable in permanently shaded regions, which may only cover ~ 10% of the surface area in the polar regions. Even ignoring the high cross sections of the south residual cap, there are regions on Mars with cross sections as high as 0.5. This nigh range of cross sections on Mars is due in some part 10 the young age of some of the surface. The mobility of small dust and sand particles, which may collect in local depressions must also contribute to the diversity of the cross section values on Mars.

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